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Christmas Shearwater Egg Dimensions and Shell Characteristics on Laysan Island, Northwestern Hawaiian Islands

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ABSTRACT.—The mean fresh egg mass of Christmas Shearwaters (*Puffinus nativitatis*) on Laysan Island, in the Northwestern Hawaiian Islands, was 44.9 ± 3.4 (SD) g, and the mean egg volume was 42.3 ± 2.9 cm^3. The measured length and breadth of the eggs, the shell mass, shell thickness, and number of pores in the shell were within 10% of predictions for procellariiform birds, based on fresh egg mass or on both fresh egg mass and incubation period. These data conform with evidence that there are few allometric differences between the eggs of tropical Procellariiformes and those of Procellariiformes from higher latitudes. *Received 19 Oct. 1998, accepted 25 Feb. 1999.*

The Christmas Shearwater (*Puffinus nativitatis*) is a tropical procellariiform seabird that breeds on islands in the central North and South Pacific oceans (Warham 1990). It has been little studied, perhaps because the species is not abundant anywhere (Shallenberger 1984). The purpose of the present note is to report data for Christmas Shearwater eggs collected on Laysan Island (28° 12′ N; 177° 20′ W) in the northwestern Hawaiian Islands.

We measured egg volume by weighing the egg in air and again submerged in water. From the difference between the mass in air and in water, and the density of water, egg volume can be determined in accordance with Archimedes' Principle (Rahn et al. 1976). We determined fresh egg mass by weighing the egg after filling the aircell with distilled water (the mass loss of the egg during incubation being entirely the result of the loss of water vapor; Grant et al. 1982), and we measured both the length and breadth of the egg with a dial caliper. We obtained the shell mass, its thickness, and we counted the number of pores in the shell of randomly-selected sub-samples of eggs after drying the shells in a desiccator. We measured pore density using the procedure described by Tyler (1953) and Roudybush and coworkers (1980).

The mean fresh egg mass of 18 Christmas Shearwater eggs was 44.9 ± 3.4 (SD) g. Knowledge of the fresh egg mass provides an opportunity to compare some of the other measured values (Table 1) with predictions for procellariiform eggs, based on the mass of their freshly laid eggs (Rahn and Whittow 1988). There are no predictive equations for the volume of the eggs of Procellariiformes, but measured egg lengths and breadths were similar (100.3% and 96.0%, respectively) to predicted values (Table 1). Measured shell mass and shell thickness were also similar (94.7% and 105.6%, respectively) to predictions (Table 1). Rahn and Whittow (1988) presented two predictive equations for the total number of pores in the eggshell. Both require the calculation of the surface area of the egg from its mass (Tullett and Board 1977), which is then multiplied by the measured pore density (Table 1). The resulting estimated total number of pores in the shell of a Christmas Shearwater's egg is 3103 pores. This value falls between the two predicted values (2963 and 3584). The predicted values were both based on the incubation period as well as on the fresh egg mass; for this purpose, we used an incubation period of 53 days (Byrd et al. 1983, Naughton 1983) and a fresh egg mass of 44.9 g.

The measured values for the eggs and eggshells of the tropical Christmas Shearwater are close to predictions for Procellariiformes in general. This finding supports evidence that there are few differences in the allometric relationships of eggs and eggshells of Procellariiformes between tropical and non-tropical species. In contrast, there are substantial differences between Procellariiformes and other

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TABLE 1. Measured and predicted values for the eggs and eggshells of Christmas Shearwaters on Laysan Island. The mean measured values (± 1 SD) are shown; n = the numbers of observations. Predicted values are calculated following Rahn and Whittow (1988).

	Measured ($\bar{x}$ ± SD)	n	Predicted
Egg			
Volume (cm^3)	42.3 ± 2.9	19	
Length (cm)	55.6 ± 2.0	22	55.5
Breadth (cm)	38.3 ± 1.3	22	39.9
Eggshell			
Mass (g)	2.9 ± 0.2	8	3.0
Thickness (mm)	0.3 ± 0.0	11	0.3
Pore density [pores $(cm^2)^{-1}$]	59.8 ± 4.7	6	

orders of seabirds in this regard (Whittow 1984, Ar and Rahn 1985).

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LITERATURE CITED

Ar, A. and H. Rahn. 1985. Pores in avian eggshells: gas conductance, gas exchange and embryonic growth rate. Resp. Physiol. 61:1–20.

Byrd, G. V., D. I. Moriarty, and B. G. Brady. 1983. Breeding biolgy of Wedge-tailed Shearwaters at Kilauea Point, Hawaii. Condor 85:292–296.

Grant, G. S., C. V. Paganelli, T. N. Pettit, and G. C. Whittow. 1982. Determination of fresh egg mass during incubation. Condor 84:121–122.

Naughton, M. 1982. Breeding biology of the Christmas Shearwater (*Puffinus nativitatis*) on Laysan Island, Hawaii. Pac. Seabird Group Bull. 9:71–72.

Rahn, H. and G. C. Whittow. 1988. Adaptations to a pelagic life: eggs of the albatross, shearwater and petrel. Comp. Biochem. Physiol. 91A:415–423.

Rahn, H., C. V. Paganelli, I. C. T. Nisbet, and G. C. Whittow. 1976. Regulation of incubation water loss in eggs of seven species of terns. Physiol. Zool. 49:245–259.

Roudybush, T., L. Hoffman, and H. Rahn. 1980. Conductance, pore geometry, and water loss of eggs of Cassin's Auklet. Condor 82:105–106.

Shallenberger, R. J. 1984. Fulmars, shearwaters and gadfly petrels. Pp. 42–56 *in* Seabirds of eastern North Pacific and Arctic waters (D. Haley, Ed.). Pacific Search Press, Seattle, Washington.

Tullett, S. G. and R. G. Board. 1977. Determinations of avian eggshell porosity. J. Zool. (Lond.) 183:203–211.

Tyler, C. 1953. Studies on egg shells. II: method for marking and counting pores. J. Sci. Food Agric. 4:266–272.

Warham, J. 1990. The petrels: their ecology and breeding systems. Academic Press, London, U.K.

Whittow, G. C. 1984. Physiological ecology of incubation in tropical seabirds. Stud. Avian Biol. 8:47–72.

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The Paint-billed Crake Breeding in Costa Rica

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ABSTRACT.—We report a recent observation from southern Costa Rica of the Paint-billed Crake (*Neocrex erythrops*), a little known species from eastern and northern South America. An adult and recently hatched chick were observed at close range in wet grassy second-growth. This observation constitutes the first record of the young of this species and represents the only breeding record for Central America. *Received 12 Nov. 1998, accepted 12 Feb. 1999.*

On 5 June 1998, at 16:30 an adult Paint-billed Crake (*Neocrex erythrops*) was observed, accompanied by a chick, near the

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